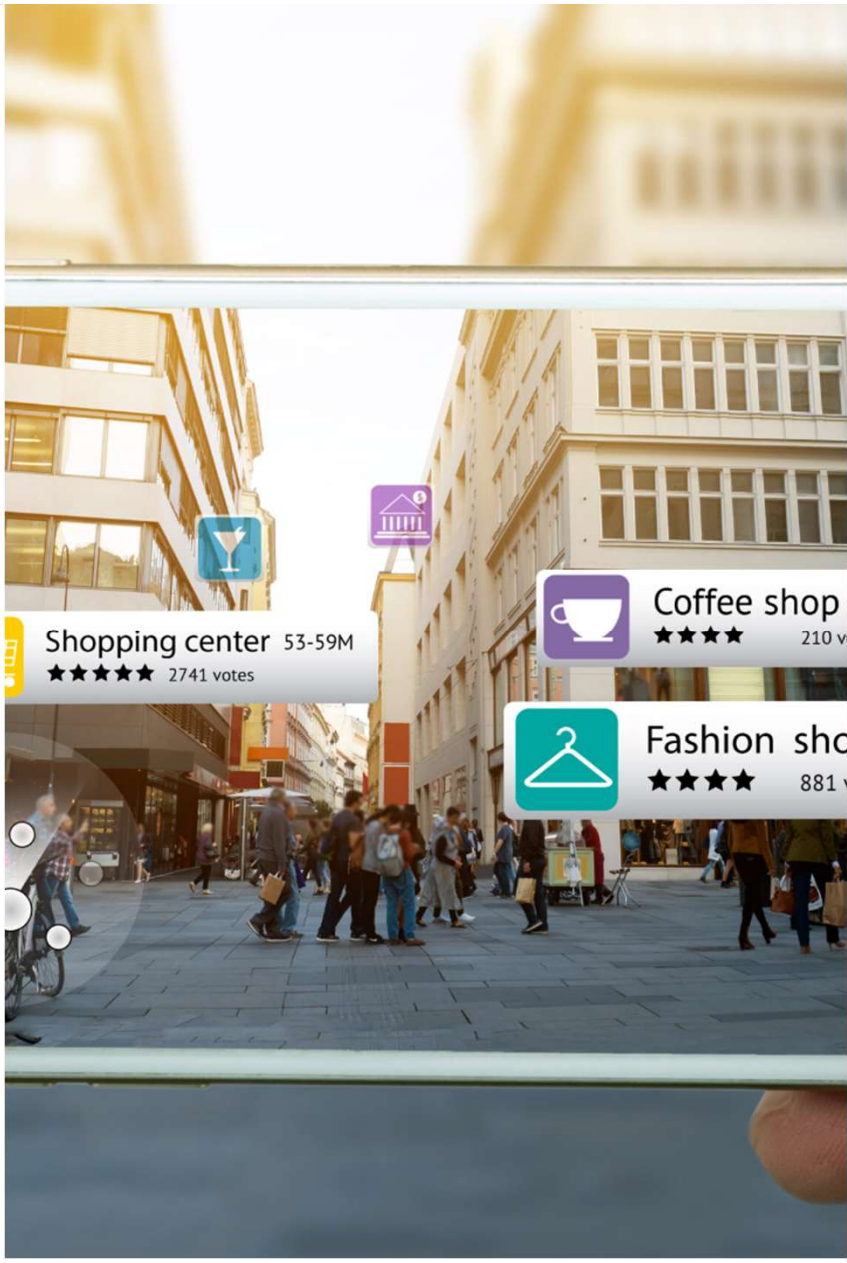
Display Models of Augmented Reality

Augmented reality creates new ways of visualizing digital information. The spatial display model explains these new visual possibilities and we will examine each one in detail.

Pp **by Poornima**



Visual Perception

1 Top-Down Processing

Our brains use prior knowledge to interpret incoming sensory information, making it easier to identify and understand.

2 Bottom-Up Processing

When sensory information is so novel that our brain cannot readily interpret it, we perceive it in a raw form.

3 Binocular Disparity

The difference between the image in the left and right eye provides the sense of depth and three-dimensionality.

4 Cognitive Load

The amount of working memory used to process the information can affect the perception and recall of visual displays.

Requirements and Characteristics

- Augmentation method
- Ocularity and stereoscopy
- Focus
- Occlusion
- Resolution and Refresh Rate
- Field of View
- Viewpoint offset
- Brightness and contrast
- Distortions and aberrations
- Latency
- Ergonomics
- Social Acceptance

Spatial Display Model

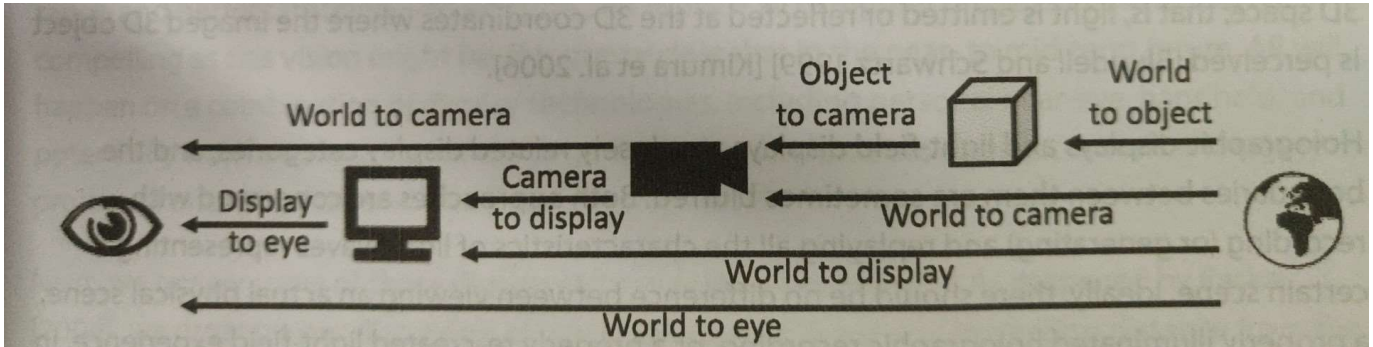


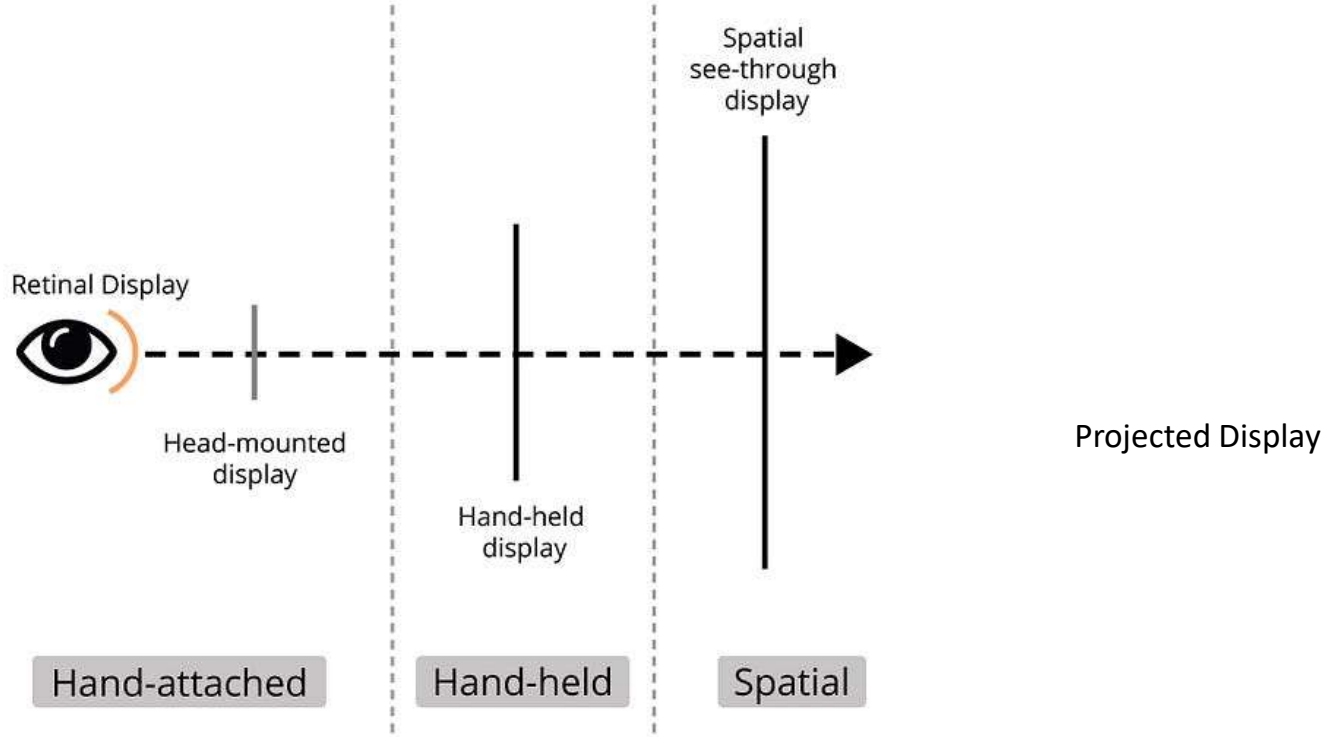
Figure 2.17 The spatial model of most AR displays can be defined as the spatial relationship of up to five components: the user's eye, the display, the camera, an object to be augmented, and the world. We depict the most important coordinate transformations here, each of which can be fixed and calibrated, tracked dynamically, or left unconstrained.

Rely on standard graphics pipeline to produce overlays on the real world through

- **Model transformation** – relationship of 3D local object and global world coordinates
- **View transformation** – 3D global world and camera view coordinates
- **Projective transformation** – 3D view and 2D device screen coordinates (offline)

- Dynamic transformations done through **tracking-** object, camera, head, eye, display

Displays in AR

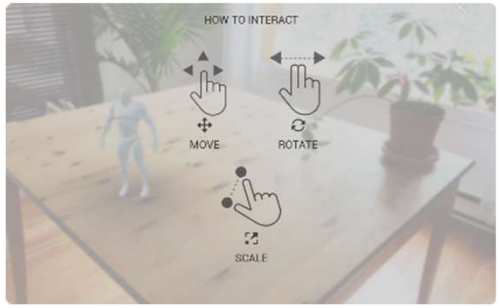


3D Displays : stereoscopic, holographic, light field, volumetric displays

Visual Displays in AR

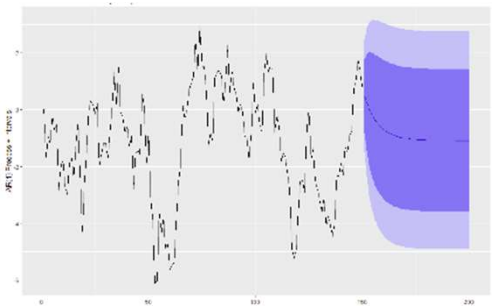
Near-Eye Displays

Head-mounted or wearable displays that project graphics directly in front of the user's eyes, creating a virtual display directly in the user's field of view.



Handheld Displays

Displays that can be held in the hands, such as smartphones or tablets, which allow graphic overlays on real world objects



Stationary Displays

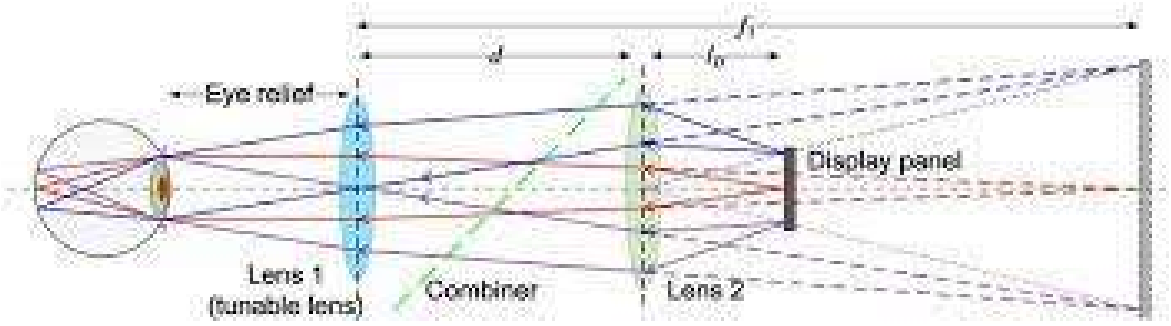
Fixed displays that do not move, such as desktop monitors or walls, and which are used to display augmented graphics on a large scale.

Projected Displays

Displays that use a projector to display augmented graphics onto a surface, such as a wall or floor, that can be interacted with in AR.

Near-Eye Visual Displays in AR

- Near Eye Displays (NED), also known as **head mounted displays (HMD) or wearable displays**, create a virtual image in the field of view of one or both eyes.
- To the eye, the virtual image appears at a distance and appears much larger than the relatively small display panel and optics used to create the image.
- The device must integrate an optical combiner, and its form factor must be accounted for.



Near-Eye Visual Displays in AR

Video See-Through

Cameras mounted on the headset capture the real world view and feed it to display panels, which then overlay digital information.

1

Optical See-Through

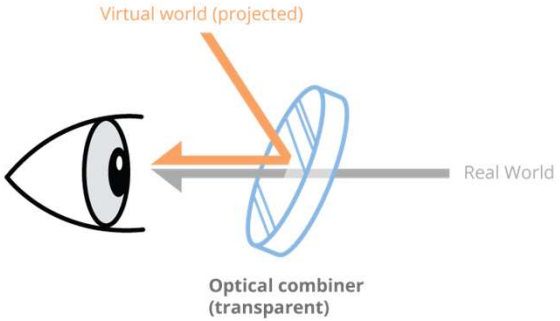
Transparent lenses that overlay digital information on the real world. This requires the user to have a clear view of their surroundings.

2

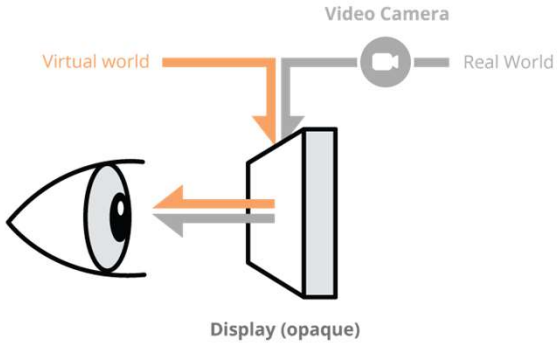
3

Hybrid Displays

Combination of the above two, allowing for both transparency and video overlays. These provide better depth perception and interaction with the real world.



Optical see-through



Video see-through

Gear VR

Hololens

Magic Leap

Meta 2

Video see-through

Optical see-through

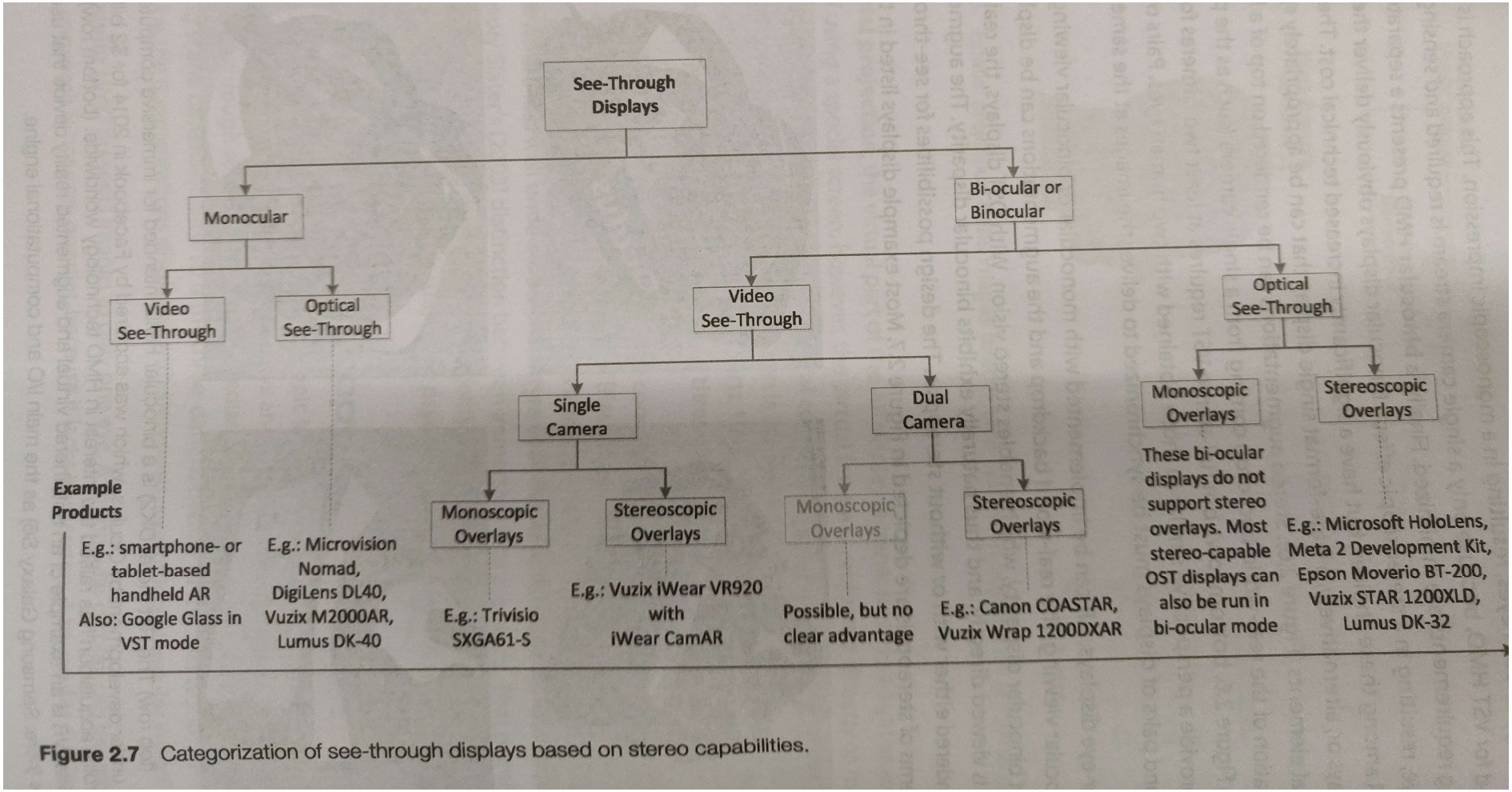


Figure 2.7 Categorization of see-through displays based on stereo capabilities.

Monocular

Biocular

Binocular

Optical Components of Near-Eye Display

- **Image Generator**
  - light-emitting diode (LED)
  - help manipulate the image a person sees when using a near-eye display by manipulating what colors they see and the contrast of the picture.

- **Optical Combiners**
  - cubed-shaped beam splitter within the tool that distributes light to the eyes
  - Augmented near-eye displays are different because they draw light from the outside world to create a picture.

Handheld Visual Displays in AR

A display technology that allows a user to see an AR world only when the display technology is held in reference to specific authored environments.

Applications

Games, shopping, location-based apps, indoor navigation and more.

Benefits

Precision, accessibility, and familiarity for users. Handheld devices allow for wider adoption and use in everyday life.

Challenges

Inconsistent user experience, limited field of view and processing power of the device, issues with accuracy and tracking.

Smartphones and tablets.

Stationary Visual Displays in AR

- Desktop displays, virtual mirror and showcases, window and portal displays

Feature	Benefits	Challenges
Large displays	Provide detailed visualizations on a large scale	Require bigger spaces to accommodate
High-resolution graphics	Provide crisp and clear graphics	Can be expensive to produce
Multi-user interaction	Allow for collaborative AR experiences	Require more powerful processing systems
Fixed location	Provide stable positions for tracking and alignment	Limit location-freedom for users

Projected Displays in AR

- Spatial AR display, view dependent spatial AR display, head mounted projector displays

Indoor Settings

- Trade shows
- Corporate presentations
- Museums and art galleries

Outdoor Settings

- Public events
- City advertising campaigns
- Architectural projections and public installations

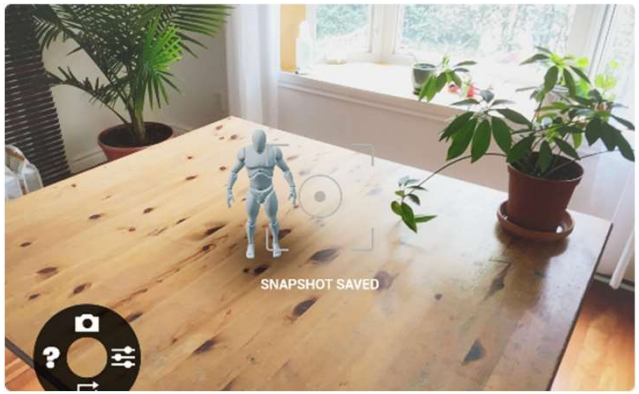
Benefits

- Highly immersive and interactive
- Flexible use for various settings
- Low-cost alternative compared to other visual displays

Types and Comparison of Visual Displays in AR

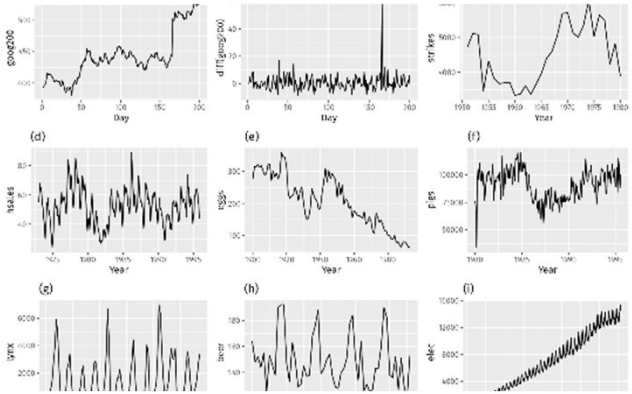
Lens-based Displays

Provide transparent overlays, flexible use beyond AR and high cost which makes it less user-friendly.



Screen-based Displays

Provide high stability, low cost, and consistent user experience, but limited field of view.



Projection-based displays

Provide larger coverage, less limitation in Field of vision and higher flexibility, lower cost and energy consumption, but lower precision and brightness.

Conclusion and Future Possibilities

The display model provides immense possibilities for visualizing digital information. As technology advances, we will see even more immersive and interactive experiences in AR using these visual displays.